Procedure for Soldermask Evaluation

DOCUMENT IDENTIFIER: A-SP-ELMF543-00-0000 Rev D, 07-May-1992

ABSTRACT: This document defines the procedures used to qualify soldermask for use within Digital.

APPLICABILITY: This process applies to all soldermasks to be used in Digital manufacturing sites.

STATUS: APPROVED 07-May-1992; use VTX SMC for current status.

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REVISION HISTORY:	Rev A,	05-Dec-1987	
	Rev B,	01-Mar-1988	ECO Number CTS01
	Rev C,	01-Feb-1990	ECO Number CTS02
	Rev D,	07-May-1992	ECO Number NRO03

Document Management Category:	Modules, Process Related (MAMP)
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APPROVAL: This document has been reviewed and approved by the Technical Review group for its category.

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1 INTRODUCTION

1.1 PURPOSE

This specification establishes the compatibility of a given soldermask with the processes presently in use at various Digital locations. This compatibility qualifies the mask for use in all Digital locations.

Soldermask material and the printed-wiring board (PWB) soldermasking process shall be free of chlorofluorocarbons (CFC) and hazardous solvents. This process is in accordance with Digital's environment conservation goal.

1.2 SCOPE

This procedure is designed to establish the compatibility of a particular soldermask with present Digital processes or to compare the relative compatibility of one soldermask to another. This procedure also qualifies a particular vendor's mask for use within all Digital manufacturing plants.

1.3 RESPONSIBILITIES

It is the responsibility of the Digital organization requesting the soldermask evaluation to provide funding for the evaluation process. The funding shall be approved and available at the time the request is submitted.

2 MATERIALS NEEDED

The following materials are required for soldermask evaluation.

Drafting pencil leads 4B through 6H inclusive
Isopropanol
Alkaline detergent 3% trisodiumphosphate and water
Small solderpot
Metal sheers or hacksaw
Flux
Soldering iron
Solder 1 pound roll (with flux core)
Tinned wire (approximately 26 through 30 gage)
Pressure-sensitive tape (3M brand transparent tape or equivalent)
IPC multipurpose test board number IPC-B-25, described in IPC-SM-840B, *Qualifications and Performance of Permanent Polymer Coating (Soldermask) for Printed Boards*

The artwork and the IPC test board are available from:
The Institute for Interconnecting and Packaging Electronic Circuits (IPC)
7380 North Lincoln Avenue
Lincolnwood, IL 60646
Telephone: (312) 677-2850

3 PROCESS ENVIRONMENT

The following is a brief description of the factory environments through which a typical printed-wiring board would be processed:

Manual (human) handling
Ambient storage

- Hand assembly tools
- Cutters
- Tweezers
- Pliers
- Soldering iron

Automatic assembly equipment

- Tooling pins
- Jigs
- Fixtures
- Clamps
- Powered carbide cutters
- Powered carbide formers
- Vision system

Robotic Handlers
Prewave solder baking
Wave solder

- Flux
- Oil (for wave)
- Sn/Pb solder (63/37) or (60/40)
- Preheaters
- Molten solder heat (500°F or 260°C)
- Conveyer (titanium fingers)
- Conveyer speeds
- SMT adhesives

Cleaner

- Isopropanol
- Deionized (DI) water
- Detergents
- Saponifiers
- Vapor temperatures
- Conveyer speeds
- Conveyer handling
- Omega meter cleanliness/test
- Isopropyl alcohol

ECO tacking adhesives
Spot masks
Rework

- Solder
- Flux
- Cleaner
- Soldering irons

4 STAGE 1—MODULE ASSEMBLY

A minimum of three module manufacturing sites shall be selected to participate in the evaluation so as to ensure the diversity of processing environments. The diversity is desired to ensure that the chemistries such as flux, adhesive, and cleaning medium, are different among the sites. For example, the solder fluxes typically used today are: rosin activated (RA), organic acid (OA), and no clean low solids content (LSF). These three types of fluxes shall be used in the evaluation.

Prior to processing at the module manufacturing sites, at least three of the IPC-B-25 Test Vehicles (TV) shall be subjected to the solvent extract test as per *Printed_Circuit Boards/Modules: Cleaning Process Contamination*, EL-MF299-00. The passing criteria for the unpopulated PWB shall be 10 or less micrograms of contaminant per square inch.

5 STANDARD SOLDERMASK TESTS

5.1 TESTS PER IPC SPECIFICATIONS

The following tests are to be performed both before and after the test sites process the PWB. All tests are to be done on IPC multipurpose test board number IPC-B-25.

NOTE

If the soldermask fails catastrophically during the first set of tests, consideration is to be given to terminating the tests at that time.

The following is taken from IPC-SM-840B, *Qualifications and Performance of Permanent Polymer Coating (Soldermask) for Printed Boards*.

Paragraph	Title
3.5.1.2	Pencil Method
3.5.2.1	Adhesion to Rigid Printed Wiring
3.6.1	Resistance to Solvents, Cleaning Agents, and Fluxes
3.7.2	Resistance to Solder
3.7.3	Soldering and Desoldering

NOTE

The *Pencil Test* and the *Adhesion to Rigid Printed-Wiring Test* must be performed on the test vehicles twice—prior to exposure to test site conditions and after exposure to test site conditions.

The other three tests will be performed as part of the test site environment, and after test site exposure.

Evaluation

The test vehicles must pass the *Pencil Tests* and *Adhesion Tests* before and after manufacturing site processing. There must not be any degradation of the vehicles; the results of the before and after tests must be essentially identical.

Adhesion of all bond materials used in the ECO wire attach process is mandatory. Any failure of adhesion is a failure of the mask.

Solder balls are a cause for soldermask failure as specified in Appendix A.

5.2 TESTS PER EL-MF601-00

Test a sample of three IPC-B-25 Test Vehicles (TV) per *Test Methods for Soldermask Cure*, EL-MF601-00. The test may be performed with the assistance of Digital's Material and Technology Analysis Lab in NRO5.

6 TEST VEHICLE SETUP

This procedure requires the use of 40 IPC-B-25 test vehicles (TV). Ten TVs shall be used as a control and are to be retained by the USME&T organization throughout the duration of the evaluation. Thirty TVs — ten for each of the three manufacturing sites — are to be processed through the evaluation test.

NOTE

If more than three manufacturing sites are participating in the evaluation, the number of TVs required must be adjusted accordingly.

Serialize all PWBs with a unique serial number. Use the following number format to insure both chronological and numerical tracking.

YYMMDDSSS	
YY = Two digit year	Example: 87
MM = Two digit month	Example: 07
DD = Two digit day	Example: 04
SSS = Three digit serial	Example: 017

For example, the serial number 870704017 should be scribed into the base material of the PWB with an electric engraving tool. This number would represent the 17th PWB in a lot that has begun evaluation on or about July 4, 1987.

After serialization, the Test Setup Form (as shown in Figure 1) should be started and completed as the evaluation progresses. This form will be used as a log for all the test vehicles and will be retained by U.S. Manufacturing Engineering and Technology (USME&T). All of the other forms, as shown in Figures 2 through 5, are to be sent with the PWB to the test sites. These four forms are to be completed by the cognizant test site engineer in charge of wave soldering and are to accompany the PWB through the evaluation process.

Test site engineers shall be notified prior to shipment of the PWB test vehicles. Notification in writing is required. Use E-MAIL, Digital internal mail, or equivalent.

NOTE

All test vehicles shall be solder plated and fused before the application of the soldermask.

Figure 1: Test Setup Form

Vendor	Serial Number	Test Site	Ship Date/ Contact	Adhesion Test	Pencil Abrasion	Solvent Extract	EL–MF601–00 Cure	Comments

Figure 2: Vapor Phase / ECO Form

Serial Number	Vapor Phase / IR Parameters						Pre–Wave ECO Wiring Parameters			
	Vision System (Can Fiducials and Patterns Be Recognized with This Mask?)	Conveyer Speed	SMT Adhesive	Medium Type and Temperature	Time in Vapor	Cleaning Medium	Number of Wires	Quantity of Adhesive Appli–cations Min. = 1	Type of Adhesives (Number)	Comments

Figure 3: Wave Solder Form

Wave Solder Parameters												
Serial Number	Run Date: Time:	Spot Mask Type	Spot Mask Location	Pre–Bake Time/ Temp.	Flux Type S.G.	Conveyer Speed	Wave Temp.	Usable Wave Width	Pre–Heater Settings			
									No. 1	No. 2	No. 3	No.4

Figure 4: Cleaning / Hand Solder Form

Serial Number	Cleaning Parameters							Hand Solder Parameters			
	Solvent (Number)	Solvent Type	Solvent Temperature	DIP vs Degrease	Conveyer Speed	Time in Cleaner	Omega Meter	Solder Type (Number)	Flux Core Type	Hand Clean Solvent Type (Number)	Cleaning Method DIP/Brush

Figure 5: ECO Wire Parameters Form

Serial Number	Post Solder Wave ECO Wiring Parameters				
	Number of Wires	Quantity of Adhesives Applications Min. = 10	Type of Adhesives (Number)	As Received Solvent Extract (Bare Board)	Comments

7 NOTIFICATION OF QUALIFICATION

The cognizant test site engineers, the USME&T engineer, and the responsible people in advanced technology engineering and in purchasing shall be notified in writing of the qualification or disqualification of a specific soldermask.

This notification shall be accompanied by all pertinent backup data that was generated throughout the qualification tests.

All test vehicles shall be archived within USME&T for a minimum of one year.

8 CRITERIA FOR QUALIFICATION OF MASK

The soldermask must pass all the process environments at the selected test sites.

The term *pass* shall mean the following:

a. All criteria outlined in the five IPC tests are met and the mask's color and finish have not been altered in any way as a result of being subjected to the five IPC tests.

b. The mask's color and finish have not been altered in any way as a result of being subjected to the test site process environment.

c. The solder ball specification requirements are met as specified in Appendix A.

APPENDIX A SOLDER BALL SPECIFICATION

This section of the specification addresses the anomalies of solder adhesion to the PWB module surface as observed after mass reflow and wave soldering processes, including localized wave.

A.1 DEFINITIONS

Solder Web:—A thin solder film or thread that is left on the printed board surface after soldering. Usually, a number of solder particles can be found on these threads.

Solder Ball:—A separate solder sphere that is adhered to the substrate surface or is embedded in the flux residues.

1. Tin/Lead Electroplated Fused PWBS

   Squeeze Up and Squeeze Out Solder Balls

   If the solder ball comes up straight through the mask, it is called *squeeze up*.
   If the solder ball comes out next to plated-through holes, it is called *squeeze out*.

2. Wave Soldering/ All Board Types

   Solder balls are spheres of solder that attach to the soldermask when the board is wave soldered. They are usually randomly dispersed over the entire surface of the printed-wiring assembly and are generally found on the solder side (side 2) of the assembly.

3. Reflow/All Board Types

   Solder balls may be observed under the bodies of components, embedded in flux on the periphery of the flux ring, attached to the solder joints—on pads, under leads or solder fillets—or randomly dispersed on substrate surface.

A.2 ACCEPTANCE CRITERIA

A.2.1 SOLDER WEBBING

Solder webbing is not acceptable if it causes a short circuit. Same acceptance criteria for solder balls.

A.2.2 SOLDER BALLS

Acceptable conditions for solder balls, listed in the following paragraphs, are deemed not to impact or degrade the functional quality or reliability of the product.

Solder balls are acceptable, provided that:

a. They are randomly dispersed across the surface of the module.

b. They are secure to the surface of the module.

c. Their diameter does not exceed —

— .005 inch diameter, on boards with solder mask

— OR

— 1/2 design space — not to exceed .005 inch — on boards without solder mask

SPECIAL CONDITIONS—SOLDER BALLS BENEATH CHIP COMPONENTS

Solder balls larger than .005 inch that are located under chip components are acceptable if they are secured by the component.

NOTE

Large quantities of solder balls are not rejectable. However, they are symptomatic of process problems that must be investigated and corrected.

A.3 PROPOSED SOLDER BALL SECURITY TEST PROCEDURE

To check for the adherence of solder balls to the surface of the printed-wiring board, a stream of dry filtered air with a minimum of 20 psi shall be used so as not to contaminate the module.

An air nozzle shall be held no higher than two inches from the surface of the board and activated. The air stream shall be directed onto the surface of the board in all directions to check the solder ball security.

NOTE

Care must be taken with the air hose to certify the safety of the operators and nearby personnel. Proper safety precautions, such as protective safety glasses and secure catch area for blown debris, shall be used.

APPENDIX B REFERENCED DOCUMENTS

B.1 EL-Class Digital Documents

EL-Class Number	Document Title
EL-MF299-00	*Printed-Circuit Boards/Modules: Cleaning Process Contamination*
EL-MF601-00	*Test Method for Soldermask Cure*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

B.2 Other Documents

Document Number	Document Title
IPC-SM-840B	*Qualifications and Performance of Permanent Polymer Coating (Soldermask) for Printed Boards*

B.3 Ordering Information

Following are the sources for documents not available from Standards and Methods Control.

- IPC documents are available from:
  The Institute for Interconnecting and Packaging Electronic Circuits (IPC)
  7380 North Lincoln Avenue
  Lincolnwood, IL 60646
  Telephone: (312) 677-2850.

APPENDIX C RELATED DOCUMENTS

C.1 EL-Class Digital Documents

EL-Class Number	Document Title
EL-00030-04	*DEC STD 030-4 Module Manufacturing Standard - Printed-Wiring Board Design Requirements*
EL-00030-05	*DEC STD 030-5 Module Manufacturing Standard - Module Assembly and Component Insertion Rules*
EL-00116-01	*DEC STD 116-1 Workmanship Standards Manual - Printed-Circuit Boards*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

C.2 Other Digital Documents

Document Number	Document Title
A-PS-1400029-GS-0000	*Soldermasks - Photoimageable Liquid or Screened Liquid, General Purchase Specification*
A-PS-1400030-01-0000	*Photosensitive Dry Film, General Purchase Specification*

C.3 Other Documents

Document Number	Document Title
IPC-TM-650	*Test Methods*
MIL-F-14256	*Military Specification, Flux, Soldering, Liquid (Rosin Base)*
QQS-5-571	*Federal Specification, Solder, Tin Alloy, Tin-Lead Alloy, and Lead Alloy*

C.4 Ordering Information

Following are the sources for documents not available from Standards and Methods Control.

- Digital purchase specifications are available from:
  Central Specification Control Systems
  NRO5/M2, any Microfilm Reference File, or the SPOC System
- Military specifications are available from:
  The Naval Publications and Forms Center
  5801 Tabor Ave., Philadelphia, PA 19120
  Telephone (215) 697-3321

- Federal specifications are available from:
  Business Service Center
  General Services Administration Regional Office
  10 Causeway Street, Boston MA 02222
  Telephone: (617) 565-5860

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